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Cardiorespiratory fitness not sedentary time or physical activity is associated with cardiometabolic risk in active older adults

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Running Head: Activity, fitness and cardiometabolic health

Abstract

Sedentary time (ST) and moderate to vigorous physical activity (MVPA) are associated with cardiometabolic health. Cardiorespiratory fitness (CRF) is also implicated but often overlooked in health recommendations. This study assessed the relationships between ST, MVPA, CRF and cardiometabolic health in highly active older individuals. 125 healthy amateur cyclists aged 55 to 79 years had their ST and MVPA levels assessed by actigraphy over a 7 day period. CRF was assessed using a maximal effort cycle ergometry test to determine VO_{2max} with results normalised to both body mass and fat free mass measured by DXA. Markers of cardiometabolic risk (blood glucose, triglycerides, cholesterol, HDL, LDL, Insulin, HOMA IR, blood pressure and body fat) were assessed and used to determine cumulative cardiometabolic risk. Multiple linear regression was used to assess ST, MVPA and CRF associations with cardiometabolic health with the relationship between activity levels and CRF determined. CRF was associated with training volume ($P = 0.003$), but not ST or MVPA. A high CRF was associated with lower cumulative cardiometabolic risk, body fat percentage, triglyceride and HDL levels ($P < 0.05$ in all cases). MVPA was negatively associated with body fat percentage while ST was not associated with any marker of cardiometabolic risk when adjusting for activity levels. An association between CRF and cardiometabolic risk even in a group of older individuals with high fitness levels highlights the importance that CRF may have in maintaining health.

Introduction

In the developed world human life expectancy has more than doubled over the past two centuries [1] leading to a dramatic rise in the number of older individuals. Unfortunately, healthy life expectancy (the healthspan) has not increased at the same rate [2] resulting in a greater proportion of old age being spent in poor health and with disability. One of the leading causes of premature death and increased morbidity in the Western world is cardiovascular disease [3]. Associated with this are a wide range of cardiometabolic risk factors including central obesity, hypertension, dyslipidaemia and hyperglycaemia, many of which cluster within individuals in the general population [4,5]. This clustering of cardiometabolic risk factors confers a significantly greater overall risk of cardiovascular disease than the sum of individual risk factors [6] and as such it is important to establish strategies aimed at minimising each cardiometabolic risk factor.

One of the greatest modifiable lifestyle factors for improving cardiometabolic health and reducing cardiovascular risk is increasing physical activity levels [7]. Sedentary time (ST), moderate-to-vigorous physical activity levels (MVPA) and cardiorespiratory fitness (CRF) are all predictors of cardiometabolic risk [5,8,9]. Independent of MVPA, prolonged periods of ST are associated with an increased cardiometabolic risk [8,10,11]. Interestingly, this relationship appears less pronounced when fitness levels are accounted for [11] indicating that the risk associated with sedentary behaviour may be partly offset by fitness levels [12]. CRF is one of the best predictors of all-cause mortality and mobility in older individuals [13,14] and is influenced by a number of factors including age, genetics and, importantly, physical activity [12,15,16]. Despite being recognised as an important factor in improving cardiometabolic risk, CRF is often overlooked when developing consensus recommendations to improve health [17]. Increasing the time spent performing moderate or vigorous levels of physical activity is

advocated for improving CRF. Recently, however, it has been reported that increased ST is also associated with lower CRF [12,18], therefore it may also be important to emphasise reducing ST when trying to improve CRF

Well-documented declines in CRF [16] and increases in cardiometabolic risk factors occur with age [19], although the extent to which these are the result of inherent ageing or the interaction of ageing with lifestyle factor remains unclear. A wide range of factors, including genetic variation, lifestyle, socio-economic status, nutritional, healthcare and environmental differences, confound our understanding of the inherent ageing process [20,21]. In particular physical inactivity is known to have serious effects on health [22]. With our genetic inheritance arising from a period when high levels of physical activity were the norm it has been argued that being physically activity is required to maintain health and physical function across the lifespan[21,23]. As such older individuals free from the confounding effects of inactivity have been suggested as the population of choice to investigate the ageing process [24,25]. We have recently performed a detailed study of such a group (master cyclists aged 55-79 years) in which objective measures of physical activity, physiological function and markers of cardiometabolic health were obtained [26]. Whilst acknowledging the role of inter- individual genetics differences on the ageing trajectory, the genotype of the cohort studied, albeit for only two 'performance' genotypes, was no different to the general population and not skewed towards an endurance based phenotype [26]. Using data obtained from this cohort the aim of the present study was to 1) investigate how CRF is influenced by markers of activity levels, specifically ST, MVPA and training volume, and 2) determine how cardiometabolic risk is influenced by ST, MVPA, CRF and age in a group of highly active older adults.

Methods

Participants

The participants of the study were amateur, non-elite, male (n = 84) and female (n = 41) cyclists aged 55 to 79 years. For full details of the cohort and inclusion / exclusion criteria see Pollock et al. [26]. The inclusion criterion for males was the ability to cycle 100 km in under 6.5 hours while females had to be able to cycle 60 km in under 5.5 hours and all participants had to have achieved this twice in the 3 weeks prior to joining the study. In addition each subject met the "healthy" criteria defined by Greig [27]. The exclusion criteria were any know cardiovascular, respiratory or neurological conditions, smoking, excessive alcohol consumption or the taking of any medications. Participants provided written informed consent and all procedures were conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the National Health Service Wandsworth Research Ethics Committee (12/LO/0457).

Participant Characteristics

The height and mass of each participant were measured using a calibrated stadiometer and balance beam scales, respectively. Whole body fat free mass (FFM) was assessed by dual-energy X-ray absorptiometry (DXA; Hologic, Bedford, MA, USA). Systolic (SBP) and diastolic (DBP) blood pressure were assessed during a 15 min period of quiet supine rest using a Finometer Pro (Finapress Medical Systems, Amsterdam, Netherlands). The average SBP and DBP recorded from those taken each minute during the final 5 mins of the rest period.

Physical Activity Assessment

Participants wore an Actigraph GT3 monitor (ActiGraph, Pensacola, FL, USA), secured to their right ankle, for a seven consecutive days. The monitor was not worn while sleeping or during water based activities. The monitors record acceleration in 3 dimensions, from which daily activity counts were determined. Activity counts were used to classify worn time as sedentary (<100 cpm), light (100 – 2689 cpm), moderate (2690 – 6166 cpm), hard (6167 – 9642 cpm) or very hard (>9642) intensity physical activity. Cut-offs for each category were based on a modified version of those described by Sasaki et al. [28]. ST and time spent performing MVPA (the sum of moderate, hard and very hard categories) were used for further analysis. ST excluded non-wear time, periods of at least 60 mins during which no activity counts were recorded, and time spent sleeping. Only those participants who wore the monitor for at least 4 days were included in the analysis. Self-reported training volume was determined from questionnaires assessing cycling history.

Cardiorespiratory fitness assessment

Cardiorespiratory fitness (CRF) was determined by having the participants perform a continuous progressive exercise test to exhaustion on a cycle ergometer (Lode Corival, Lode, Groningen, Netherlands). Maximal oxygen uptake ($\dot{V}O_{2max}$) was measured via breath-by-breath respiratory gas analysis (Oxycon Pro, CareFuison, UK). The test began with a 3 min period of cycling at a work rate of 50 W after which power output was continually increased. This continued until the participant could no longer continue despite strong verbal encouragement. The rate of increase (1 to 2 W every 3 to 5 s) was customised for each participant such that maximal effort would be reached within 10 to 12 mins. Participants cycled at a self-selected cadence, typically between 75 and 80 rpm. Heart rate was continually monitored by 12 lead ECG throughout the test. The greatest oxygen uptake over a 20 s period at the end of the test was taken as the participant's maximal oxygen uptake

($\dot{V}O_{2max}$). To ensure a true maximal effort had been reached at least two of the following criteria had to be met: (1) a recorded maximum heart rate greater than age predicted maximum (220 – age), (2) a respiratory exchange ratio of >1.15 and (3) a plateau on $\dot{V}O_2$, indicated by $\dot{V}O_2$ increasing by ≤ 100 ml.min^{-1} during the final two 20 s periods of the test [29,30]. $\dot{V}O_{2max}$ is expressed as millilitres of oxygen uptake per kilogram of fat free mass (FFM) per minute (ml.kg[FFM]$^{-1}$.min^{-1}).

Cardiometabolic risk assessments

The measurements used to assess cardiometabolic risk were those that we have previously presented [26] which are also identified by the International Diabetes Foundation [4] as being associated with the metabolic syndrome. Blood samples were obtained following an overnight fast with serum samples frozen (-80 ºC) and stored for future analysis. Serum levels of glucose, triglycerides, cholesterol, HDL and LDL were measured by the Clinical Laboratory in the Queen Elizabeth Hospital Birmingham using a Roche Modular automated system. Insulin levels were measured by the blood science laboratories located in Guy's and St Thomas' NHS trust using a chemiluminescence immunoassay and the Immulite Xpi. Using the glucose and insulin results insulin resistance (HOMA IR) was determined with the HOMA2 computer model.

The use of a continuous metabolic risk score has more statistical power than dichotomous variables while the combination of multiple risk factors also better represents cardiometabolic risk [9,31]. As such a clustered cardiometabolic risk (CCMR) score was calculated to better represent overall cardiometabolic risk. CCMR incorporated body fat percentage, SBP, DBP, glucose, insulin, HOMA IR, triglycerides, cholesterol, HDL and LDL. For each of these variables individual sex specific standardised values were computed (i.e. z score = [recorded

value – group mean value]/standard deviation). Due to a non-normal distribution, data for glucose, insulin, HOMA IR, cholesterol and triglycerides were log transformed prior to calculation of z-scores. Individual z scores were then summed, using the inverse of z HDL, and divided by the total number of variables included to give a CCMR score. The greater a participant's CCMR score the less favourable their overall cardiometabolic risk compared to the cohort as a whole.

Statistical Analysis

All statistical analysis was performed using IBM SPSS Statistics v23 (Chicago, Il, USA). The normality of the data was assessed using the Kolmogorov-Smirnov test. Gender differences were assessed using Students T-test for normally distributed data and Mann-Whitney-U tests for non-normally distributed data. Multiple linear regression was performed to examine CRF associations with ST, MVPA and training volume. Each exposure was initially assessed independently followed by fully adjusted modelling including all exposures (ST, MVPA and training volume). Age and sex were adjusted for in all models as covariates. Similarly, multiple linear regression was used to assess the influence of ST, MVPA, CRF or age with cardiometabolic risk (Model 1). Subsequently a full adjusted model with all exposures included (ST, MVPA, CRF and age – Model 2) was computed. In both Model 1 and Model 2 age was adjusted for as a covariate. A log transform was applied to glucose, insulin, HOMA IR, cholesterol and triglycerides to provide a normal distribution. Activity monitor wear time can be associated with wear time, however, adding this to the analysis had minimal effect on the results. Therefore to minimise the number of variables included in the regression wear time was excluded from the analysis. In order to be able to compare the effects of each variable in the regression equation standardised coefficients were calculated. Regression coefficients and 95 % CI are presented. Alpha was set at 0.05.

Results

Participant characteristics are presented in Table 1. Four male subjects were excluded from the analysis due to insufficient activity monitor wear time. A significant age difference between males and females was present with male participants being 2.5 years older than females ($P = 0.029$). As expected males were taller, heavier and had a lower percentage body fat than females ($P < 0.001$). Cholesterol, HDL and LDL levels were lower in males than females ($P < 0.01$). No gender differences were apparent with any other variables ($P > 0.05$).

Associations with CRF are shown in Figure 1. When assessed independently, CRF was found to be associated with training volume (beta = .267, 95 % CI [0.127, 0.442]; $P = 0.001$) but not ST ($P = 0.982$) while there was a trend towards an association with MVPA ($P = 0.079$). After adjusting for all exposures training volume was associated with CRF (beta = 0.245, 95 % CI [0.085, 0.422]; $P = 0.003$) while no associations with ST ($p = 0.258$) or MVPA ($P = 0.294$) were found.

The results of the multiple linear regression analysis can be found in Table 2**Error! Reference source not found.**. CRF was positively associated with HDL levels and negatively associated with CCMR, body fat percentage SBP, DBP and triglyceride levels (Model 1). After adjusting for the other exposures (Model 2) associations between CCMR, body fat percentage, triglyceride and HDL levels remained but not for SBP and DBP. ST was not associated with any marker of cardiometabolic risk assessed by Model 1 or 2. MVPA was negatively associated with body fat percentage before (Model 1) and after (Model 2) adjusting for all other exposures only. Age was associated with SBP (Model 1) but not after adjusting for other exposures (Model 2). The only other age association observed was with HDL levels after adjusting for all exposures (Model 2).

Discussion

The findings of the current study revealed that in highly active older individuals training volume, rather than time spent sedentary or performing MVPA, was associated with CRF. Also, in older individuals whose activity levels far exceed the current recommended physical activity guidelines age, ST and MVPA were not associated with cardiometabolic health whereas greater levels of CRF were associated with lower cardiometabolic risk. While reverse-causality cannot be excluded, the associations between CRF and cardiometabolic risk, in highly active individuals with good cardiorespiratory health, further highlights the potential benefits of maintaining good CRF on cardiometabolic health.

Associations between activity levels and CRF

While CRF is known to decline with age, the influence of age associated reductions in physical activity levels on this are often overlooked [16,26]. Longitudinal studies have revealed that, in older endurance trained athletes, declines in CRF are highly dependent on the training stimulus with reductions in CRF being associated with reduced absolute training levels [32]. This is supported by the current study where training volume was found to be positively associated with CRF. While it may be expected that CRF would also be associated with higher levels of MVPA, the lack of association in the present study may be explained by the minimal effect training intensity alone has on CRF with low volume high intensity training having similar effects to high volume low intensity training [33]. The greater variability in training volume compared to levels of MVPA, along with few individuals performing low volume high intensity training, likely accounts for training volume being the only factor associated with CRF. Training volume being associated with CRF, even in a group of highly active and aerobically fit older individuals, highlights the need for activity levels, and in

particular declining activity levels, to be controlled for when investigating the effect of age on CRF.

The importance of sedentary behaviour on CRF and overall health has recently been brought to prominence [17]. An investigation of 2223 individuals aged 12 to 49 years revealed that, after accounting for exercise time, ST is inversely associated with CRF [12]. Similarly in a group aged 60 to 69 years, irrespective of MVPA levels, ST was negatively associated with CRF while having breaks in ST where light activity is performed can reduce this association [18]. In the present study we found no association between ST and CRF which may be ascribed to the activity levels of the current cohort. Compared to previous studies [12,18] the activity levels of the current cohort are extremely high. It is possible that the exercise levels of the subjects in the present study are well above that required to offset the negative effects of inactivity and thereby prevent any association between ST and CRF being observed.

Determinants of cardiometabolic risk

Ageing is typically associated with increasing cardiometabolic risk [19] although the extent to which this is due to the ageing process or the combined effect of ageing and lifestyle factors, in particular inactivity, is unknown. Through the study of individuals who have activity levels well above that expected to offset the effects of inactivity, cumulative cardiometabolic risk and, with the exception of HDL, individual markers of cardiometabolic risk were not associated with age. The lack of age associations in this group who do not suffer from the confounding effects of inactivity may reflect the fact that ageing *per se* has a lower influence on cardiometabolic health, whilst lifestyle factors may play a greater role. While much attention has been given to ST, MVPA, CRF and their association with cardiometabolic risk few studies have objectively measured each of these variables simultaneously and identified

how they are associated [9]. In support of the present findings, studies investigating all three factors (ST, MVPA and CRF) have concluded that CRF is associated with clustered cardiometabolic risk or the metabolic syndrome [9,34–37]. The majority of previous studies have been cross-sectional in nature and include individuals with relatively wide age ranges and levels of fitness and may therefore, due to the inclusion of highly fit individuals with low cardiometabolic risk and unfit individuals with high cardiometabolic risk, be expected to find greater associations than the present study . Whilst acknowledging the limitations associated with the cross-sectional nature of the current study [20] and the potential for reverse causality, the maintenance of an association between cardiometabolic health and CRF in individuals of relatively similar age and, compared to other studies, a very high and relatively homogenous fitness level highlights the potential importance of CRF in determining cardiometabolic health.

Whilst the importance of maintaining CRF appears well established there is greater debate as to the influence of ST and MVPA. In the present study ST had no influence on any marker of cardiometabolic risk. In contrast, the majority of previous studies considering ST, MVPA and CRF has found that increased ST is associated with increased clustered cardiometabolic risk [34–37] although in only two studies did this remain significant after adjusting for CRF and activity levels [34,36]. Similar to the present study when investigating 341 individuals with a median age of ~54 years, Knaeps *et al*. [9] found no association between ST and clustered cardiometabolic risk which they partly attributed to the mediating effect of age on this relationship. It is possible that the effects of ST may only become important once a certain age is reached [35] with a threshold of >60 years suggested [9]. Given the average age of ~63 years of participants in the current study, our findings suggest that this may not be the case. The effect of ST may therefore become apparent in aged populations only when physical

activity levels [35] or CRF fall below a critical threshold. If this is the case it further highlights the importance of accounting for activity levels and CRF in ageing research.

As with ST, associations between cardiometabolic risk and MVPA are less clear. It has been reported by some that MVPA is associated with lower cardiometabolic risk [35,36] while others have not found this association [9]. The only association found with MVPA in the current study was with body fat percentage. While a causal relationship between MVPA and body fat percentage has not been established in the present study given the importance of obesity and its influence on mortality and numerous health conditions [38] this is an interesting finding potentially indicating that, independent of fitness level, MVPA may have a role to play in improving body fat percentage. In a large scale (n = 874) cross-sectional study comparing individuals with high fitness levels to those with low fitness levels an association between activity levels and the metabolic syndrome has been established with this association being much greater in unfit individuals [39]. Taken together these findings support the assertion that unfit individuals could improve their metabolic health independently of improving CRF [35] a fact which should be considered when prescribing exercise as many individuals in need of this may initially find it difficult to perform the intensity of exercise required to improve CRF. Compared to individuals with low fitness levels those with high, as is the case in the present study, do not appear to show an association between MVPA and cardiometabolic risk [39].

Currently international guidelines suggest for adults that a minimum of 150 minutes of moderate intensity aerobic activity, 75 mins of vigorous intensity aerobic activity or a combination of both should be performed to reduce the risk of non-communicable diseases and improve cardiorespiratory and muscular fitness [40]. Large scale population based studies have revealed a dose response association between sedentary time and mortality from all

cause cardiovascular disease that remains even in individuals who meet the recommended physical activity guidelines [41]. Although not a measure of mortality, cardiometabolic risk was not associated with ST in the present study likely due to the high levels of CRF of the cohort which is more strongly associated with all-cause mortality than levels of physical activity *per se* [42]. There are a myriad of studies that support reducing ST and increasing MVPA to improve health and wellbeing. Similarly there is a growing body of evidence supporting the health benefits of improving CRF although surprisingly little attention has been paid to this with it not currently reflected in consensus recommendations [17]. Despite investigating a cohort with CRF levels exceeding a threshold above which benefits from this may not have been anticipated an association between CRF and cardiometabolic risk was found. That this association is apparent even in highly active and fit individuals further emphasises the potential importance of CRF on health

Strengths and Limitations

One of the main strengths of the study was that CRF was assessed via maximal effort exercise testing with strict criteria set acceptance of a maximal oxygen uptake thereby minimising any errors due to the prediction of maximal based on a submaximal test. Also, objective measures of physical activity levels were made using Actigraph monitors, with strict inclusion criteria applied, rather than relying on self-reported activity levels which have questionable validity and reliability. The Actigraph monitors utilised in the present study are predominately used to assess ambulatory activities with cycling often poorly detected [28]. Given that the subjects in the present study were cyclists the monitor was positioned on the ankle in an attempt to better detect cycling based activities. Given the lack of validation of the Actigraph monitor cut-offs in this position, which is a limitation of the study, care should be taken when comparing the activity levels recorded to those of previous research. There

are known limitations in cross-sectional research related to between subject differences such as lifestyle, diet, environment and genetics [20], while this study design cannot assess causality. Ideally, longitudinal studies are required to allow accurate assessment of the relationships between ST, MVPA, CRF and cardiometabolic risk.

Conclusions

Overall we found that CRF is the greatest predictor of cardiometabolic health in highly active older individuals with high fitness levels, while there was minimal effect of age and MVPA. In this group ST did not appear to be associated with cardiometabolic health. Finally, in fit older individuals the greatest determinant of CRF appears to be total training volume with no association between MVPA and ST found for this. The associations found between CRF and cardiometabolic risk, even in highly active individuals with good cardiorespiratory health, further highlights the potential benefits of maintaining good CRF.

Perspective

In the developed world there has been a dramatic increasing in life expectancy over the past century. Unfortunately, healthspan has not increased at the same rate resulting in a greater proportion of later life being spent in poor health. Efforts to improve public health have largely focused on increasing levels of moderate-to-vigorous physical activity and reducing sedentary time, with both activities associated with improved cardiometabolic health. There is a growing body of evidence indicating that having a high level of cardiorespiratory fitness ($\dot{V}O_{2max}$) is itself associated with health, although, this parameter is often not included when developing consensus recommendations[17]. Our findings of a positive association between VO_{2max} and cardiometabolic health in a group of older individuals with a highly active

lifestyle reinforces that recommendations on the maintenance and improvement of cardiorespiratory fitness *per se* should also be considered.

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Tables

Table 1. Participant characteristics and cardiometabolic risk factors

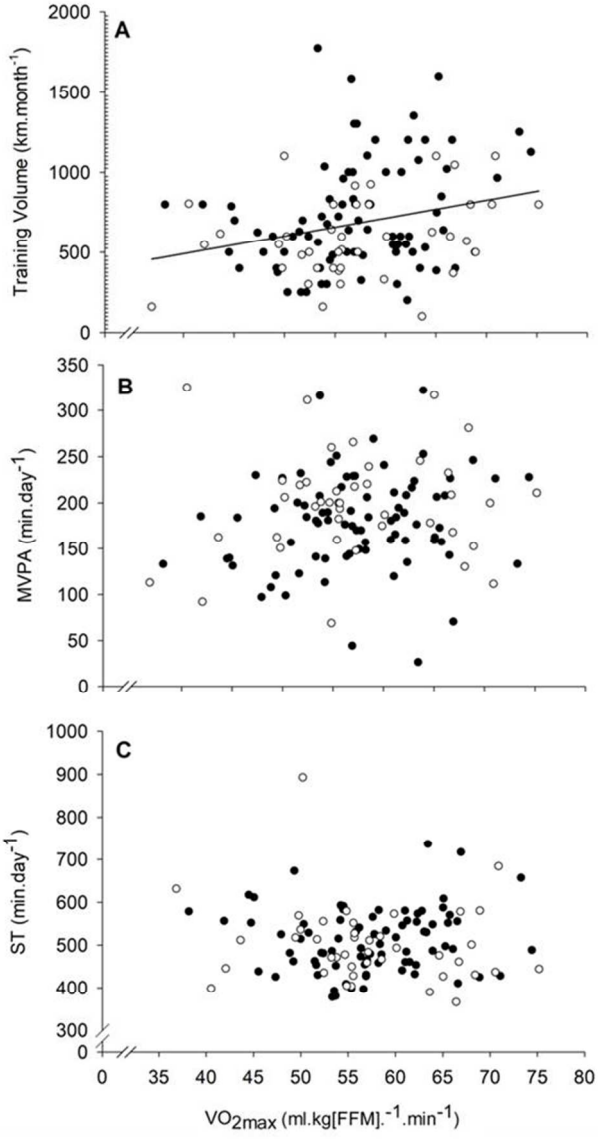
Values are mean ± SE. ST – sedentary time, MVPA – moderate to vigorous physical activity, SBP = systolic blood pressure, DBP – diastolic blood pressure, HDL – high-density lipoprotein, LDL – low density lipoprotein. * indicate significant difference between genders ($P < 0.05$).

Table 2. Standardised regression coefficients of CRF, ST, MVPA, and age for markers of cardiometabolic risk.

Standardised regression coefficients [95% confidence interval] are presented for model 1 and model 2. ST – sedentary time, MVPA – moderate to vigorous physical activity, SBP = systolic blood pressure, DBP – diastolic blood pressure, HDL – high-density lipoprotein, LDL – low density lipoprotein. * $P < 0.05$, ** $P < 0.01$.

Figures

Figure 1. Cardiorespiratory fitness associations with training volume (A), moderate-to-vigorous physical activity (B) and sedentary time (C). Males are represented by filled circles and females by open circles. Significant associations are indicated by the solid lines. Panel A r = .265, P = 0.003.



113x190mm (150 x 150 DPI)

Table 1. Participant Characteristics and Cardiometabolic Risk Factors

	Female	Male
Age (years)	62.1 ± 0.9	64.6 ± 0.7*
Height (m)	1.64 ± 0.01	1.77 ± 0.01*
Mass (kg)	60.0 ± 1.0	75.4 ± 1.0*
Percentage body fat (%)	28.4 ± 0.8	20.9 ± 0.4*
Training Volume ($km.month^{-1}$)	596 ± 40	728 ± 37*
ST ($min.day^{-1}$)	502 ± 14	510 ± 8
MVPA (min.day-1)	199 ± 9	179 ± 6
$\dot{V}O_{2max}$ ($ml.kg^{-1}.min^{-1}$)	41.1 ± 1.1	45.5 ± 0.7
$\dot{V}O_{2max}$ ($ml.kg[FFM]^{-1}.min^{-1}$)	57.3 ± 1.3	57.5 ± 0.8
SBP (mmHg)	129 ± 2	134 ± 2
DBP (mmHg)	68 ± 1	70 ± 0.7
Insulin (pmol.l-1)	34.5 ± 3.1	41.8 ± 2.8
HOMA IR	0.66 ± 0.06	0.8 ± 0.05
Glucose ($mmol.l^{-1}$)	5.37 ± 0.08	5.51 ± 0.05
Cholesterol (mmol.l-1)	6.41 ± 0.16	5.47 ± 0.11*
Triglycerides (mmol.l-1)	0.96 ± 0.06	0.97 ± 0.04
HDL (mmol.l-1)	2.26 ± 0.09	1.94 ± 0.06*
LDL (mmol.l-1)	3.72 ± 0.15	3.09 ± 0.11*

Values are mean ± SE. ST – sedentary time, MVPA – moderate to vigorous physical activity, SBP = systolic blood pressure, DBP – diastolic blood pressure, HDL – high-density lipoprotein, LDL – low density lipoprotein. * indicate significant difference between genders ($P < 0.05$).

Table 2. Standardised regression coefficients of CRF, ST, MVPA, gender and age for markers of cardiometabolic risk.

	Model	ST	MVPA	CRF	Age
CCMR	1	-0.043 [-0.226, 0.139]	-0.077 [-0.261, 0.108]	-0.295 [-0.477, -0.126]**	0.088 [-0.096, 0.274]
	2	-0.076 [-0.274, 0.123]	-0.066 [-0.270, 0.137]	-0.340 [-0.548, -0.129]**	-0.100 [-0.312, 0.112]
Body Fat	1	0.012 [-0.127, 0.151]	-0.158 [-0.296, -0.021]*	-0.199 [-0.331, -0.067]**	0.030 [-0.108, 0.169]
	2	-0.058 [-0.207, 0.092]	-0.154 [-0.307, 0.000]*	-0.230 [-0.388, -0.072]**	-0.098 [-0.258, 0.062]
SBP	1	-0.044 [-0.226, 0.138]	-0.103 [-0.287, 0.082]	-0.29 [-0.470, -0.121]**	0.285 [0.110, 0.466]**
	2	-0.117 [-0.313, 0.079]	-0.140 [-0.343, 0.062]	-0.174 [-0.382, 0.035]	0.185 [-0.028, 0.398]
DBP	1	0.052 [-0.132, 0.236]	-0.071 [-0.258, 0.116]	-0.198 [-0.379, -0.021]*	0.094 [-0.091, 0.280]
	2	0.039 [-0.168, 0.245]	-0.026 [-0.240, 0.187]	-0.202 [-0.422, 0.018]	-0.026 [-0.250, 0.198]
Insulin	1	-0.047 [-0.233, 0.139]	-0.047 [-0.236, 0.142]	-0.054 [-0.239, 0.129]	-0.088 [-0.275, 0.098]
	2	-0.069 [-0.278, 0.140]	-0.058 [-0.272, 0.156]	-0.123 [-0.340, 0.094]	-0.144 [-0.365, 0.076]
HOMA IR	1	-0.049 [-0.235, 0.137]	-0.043 [-0.232, 0.145]	-0.059 [-0.244, 0.124]	-0.085 [-0.272, 0.101]
	2	-0.069 [-0.277, 0.140]	-0.054 [-0.268, 0.160]	-0.128 [-0.344, 0.089]	-0.144 [-0.365, 0.076]
Glucose	1	-0.035 [-0.219, 0.150]	0.051 [-0.136, 0.238]	-0.146 [-0.328, 0.033]	0.031 [-0.154, 0.216]
	2	0.001 [-0.207, 0.209]	0.077 [-0.137, 0.290]	-0.186 [-0.405, 0.033]	-0.073 [-0.295, 0.148]
Cholesterol	1	-0.036 [-0.206, 0.134]	0.036 [-0.136, 0.209]	-0.002 [-0.176, 0.171]	0.024 [-0.151, 0.201]
	2	-0.028 [-0.223, 0.166]	0.019 [-0.181, 0.219]	0.030 [-0.175, 0.234]	0.026 [-0.180, 0.233]
Triglycerides	1	-0.149 [-0.334, 0.037]	0.083 [-0.107, 0.273]	-0.198 [-0.383, -0.019]*	-0.01 [-0.199, 0.178]
	2	-0.112 [-0.318, 0.094]	0.071 [-0.141, 0.282]	-0.287 [-0.503, -0.070]**	-0.168 [-0.387, 0.051]
HDL	1	0.019 [-0.159, 0.197]	0.051 [-0.130, 0.231]	0.006 [0.033, 0.389]*	0.070 [-0.111, 0.256]
	2	0.017 [-0.177, 0.210]	0.008 [-0.190, 0.206]	0.350 [0.147, 0.553]**	0.253 [0.047, 0.458]*
LDL	1	-0.031 [-0.210, 0.148]	0.006 [-0.176, 0.188]	-0.095 [-0.274, 0.080]	0.000 [-0.180, 0.180]
	2	-0.023 [-0.227, 0.180]	0.013 [-0.196, 0.222]	-0.126 [-0.341, 0.088]	-0.074 [-0.291, 0.143]

Standardised regression coefficients [95% confidence interval] are presented. ST – sedentary time, MVPA – moderate to vigorous physical activity, SBP = systolic blood pressure, DBP – diastolic blood pressure, HDL – high-density lipoprotein, LDL – low density lipoprotein. * $P < 0.05$, ** $P < 0.01$.